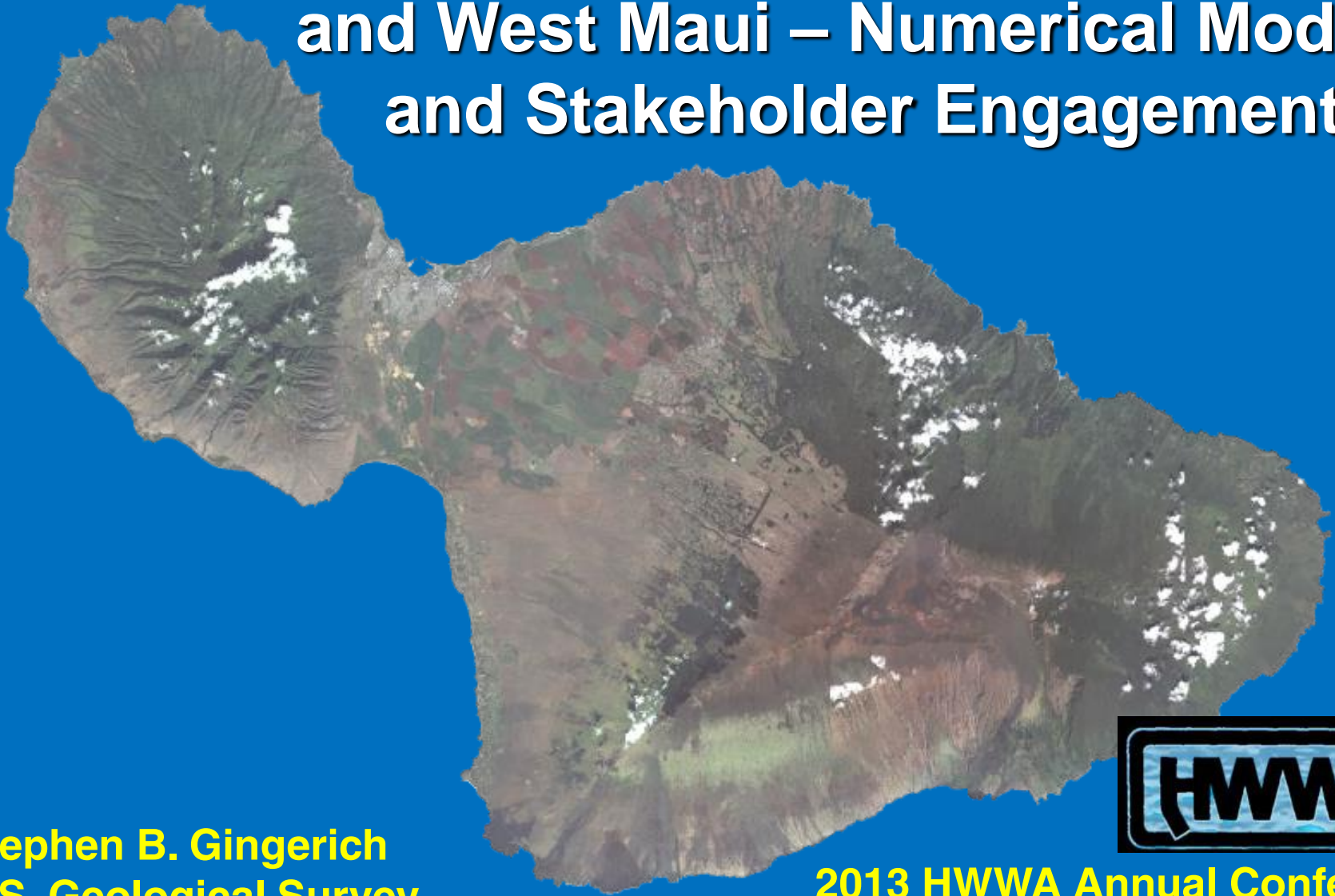


# Groundwater Availability in Central and West Maui – Numerical Models and Stakeholder Engagement

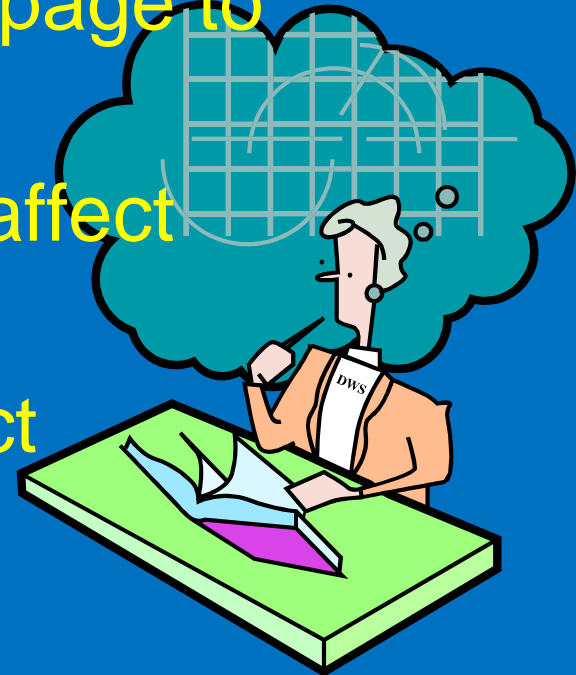


**Stephen B. Gingerich**  
U.S. Geological Survey  
Pacific Islands Water Science Center

**2013 HWWA Annual Conference**  
**Mākena, Maui**  
**October 23-25, 2013**

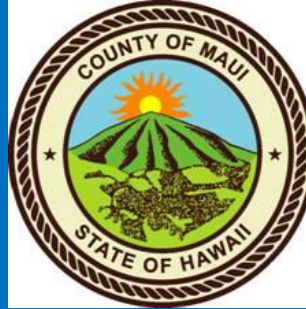
# Groundwater Management Questions

- Are current pumping rates sustainable?
- Where should we drill to get more water?
- How should we redistribute pumpage to maximize yield?
- How does wastewater injection affect groundwater system
- How will stream restoration affect groundwater system?



# Stakeholders

Department of Water Supply



West Maui Land Company, Inc.



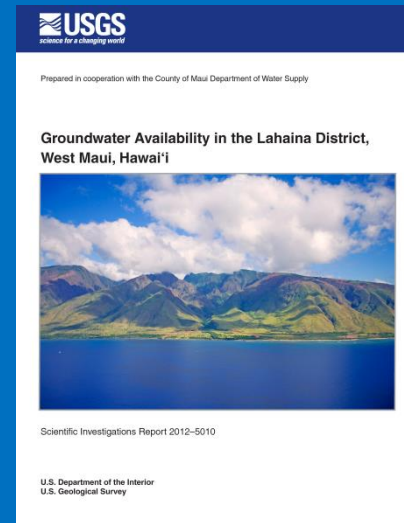
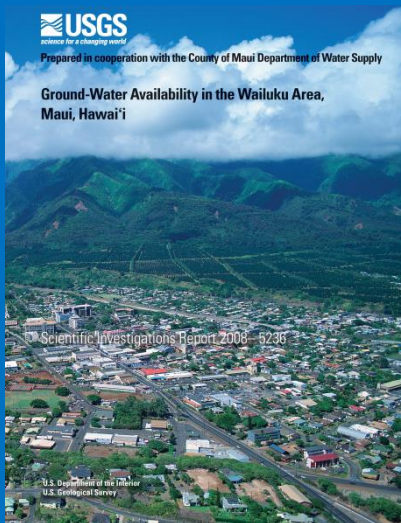
Wailuku Water Company



Hui o Na Wai `Eha

# Groundwater Availability Study Approach

- Collect and analyze hydrologic data
- Estimate groundwater recharge
- Develop and calibrate numerical groundwater model
- Predict future salinities and water levels with current and redistributed pumping conditions





# Climate Data



# Water-Level Data

Measuring point resurvey



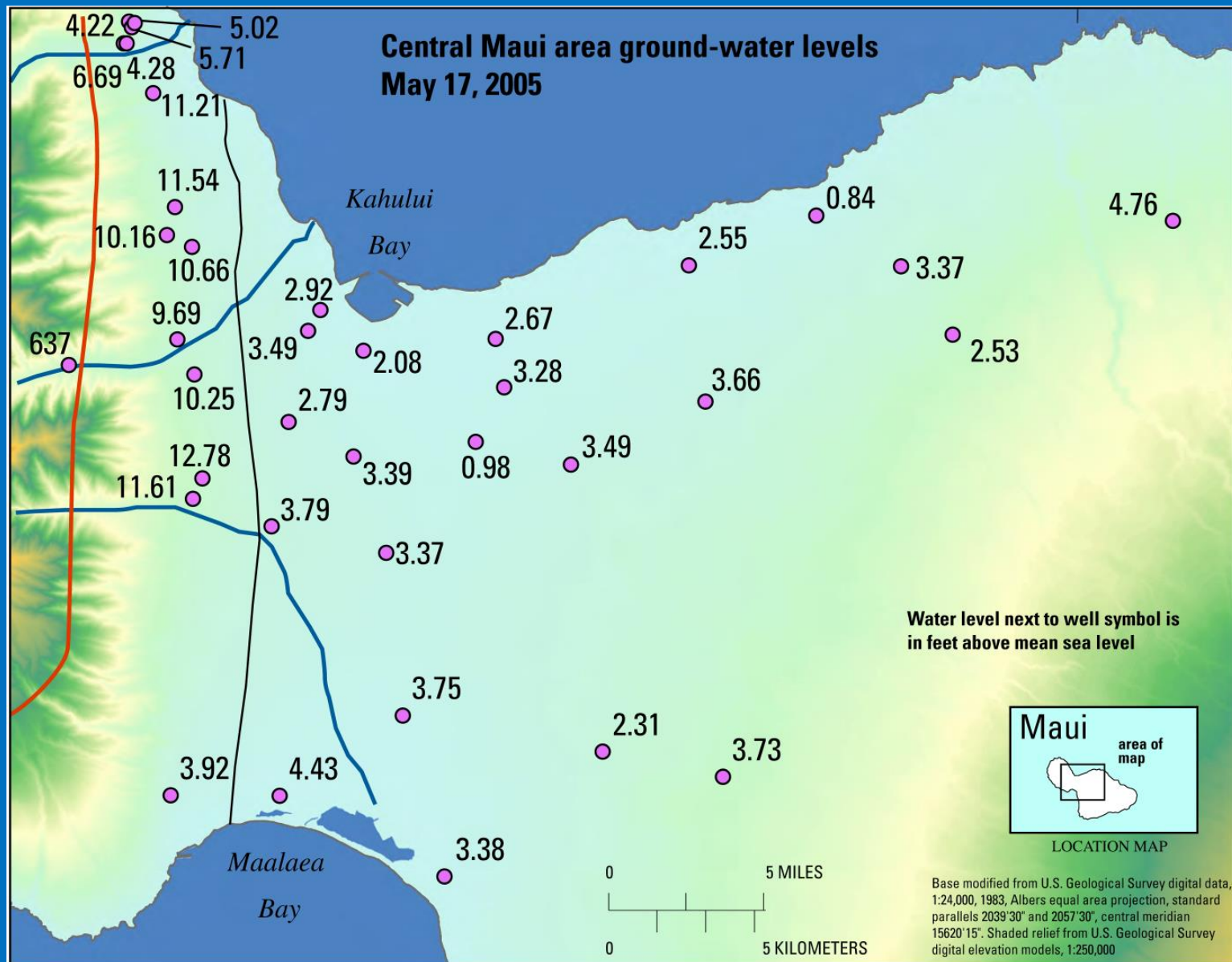
Benchmark elevation using GPS



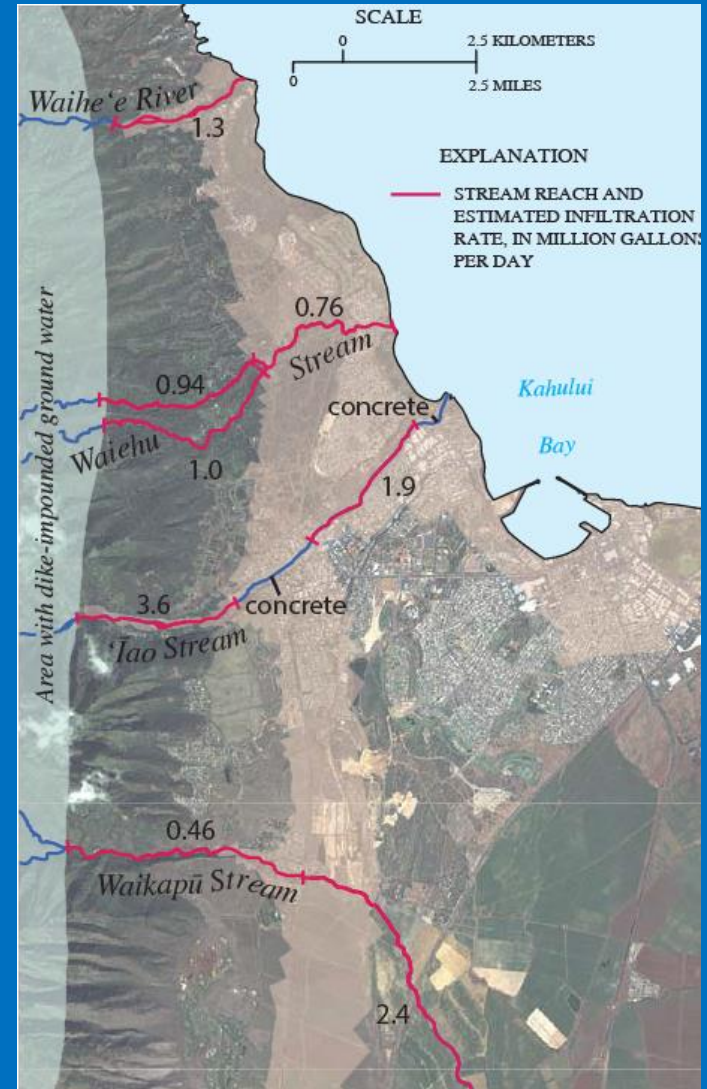
Water-level measurement



# Synoptic Water-Level Surveys

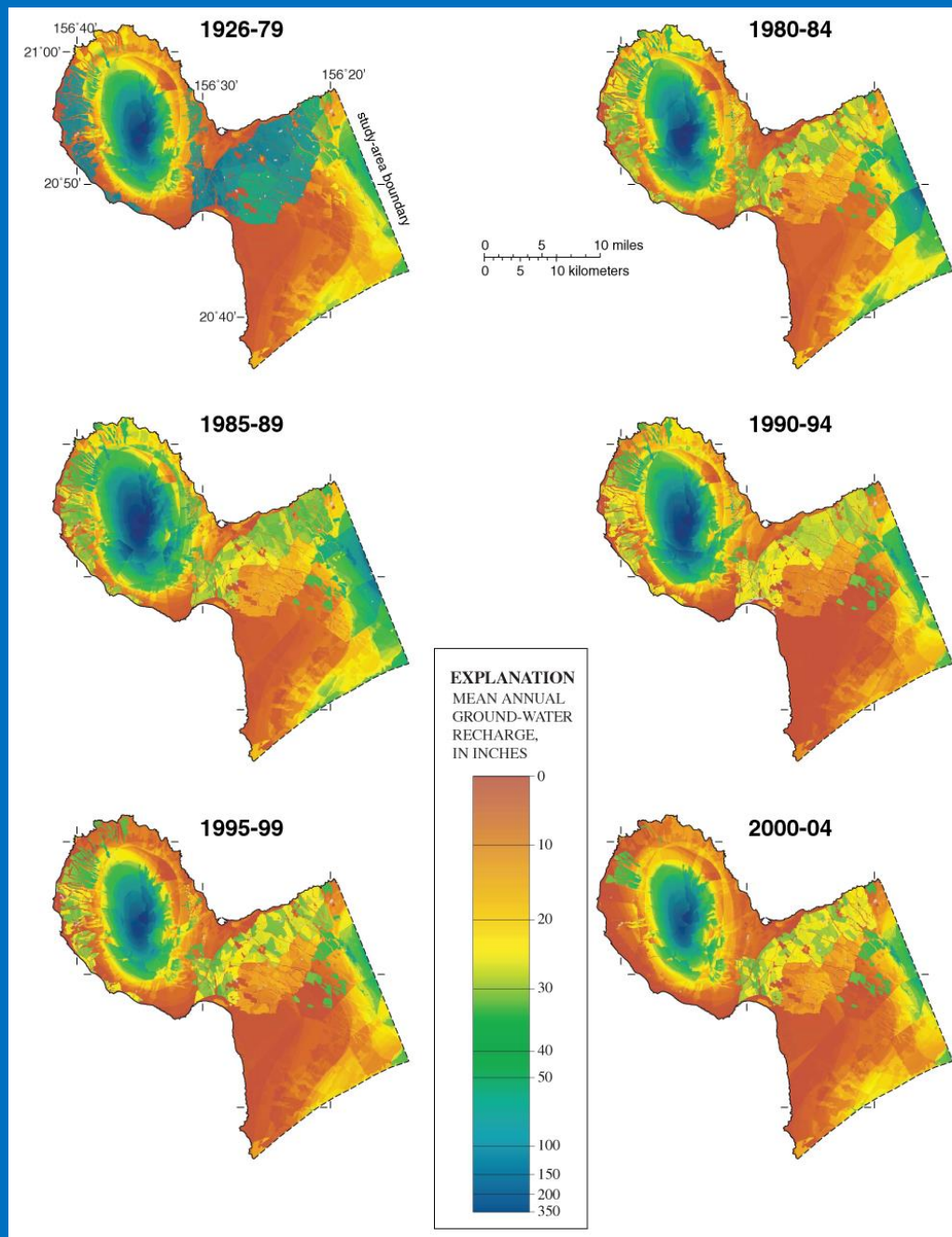


# Quantify Groundwater Discharge to Streams

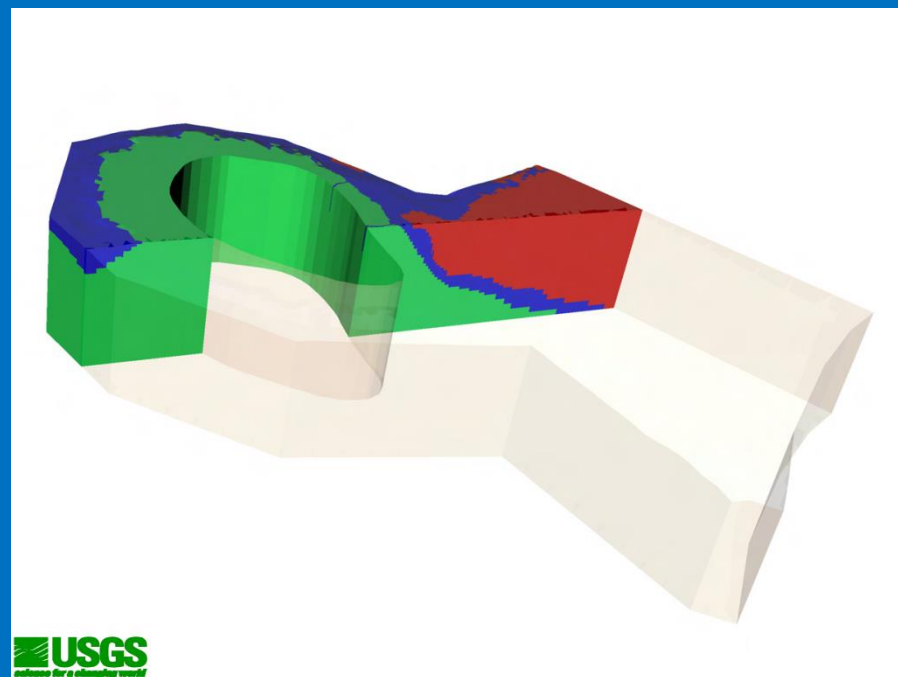
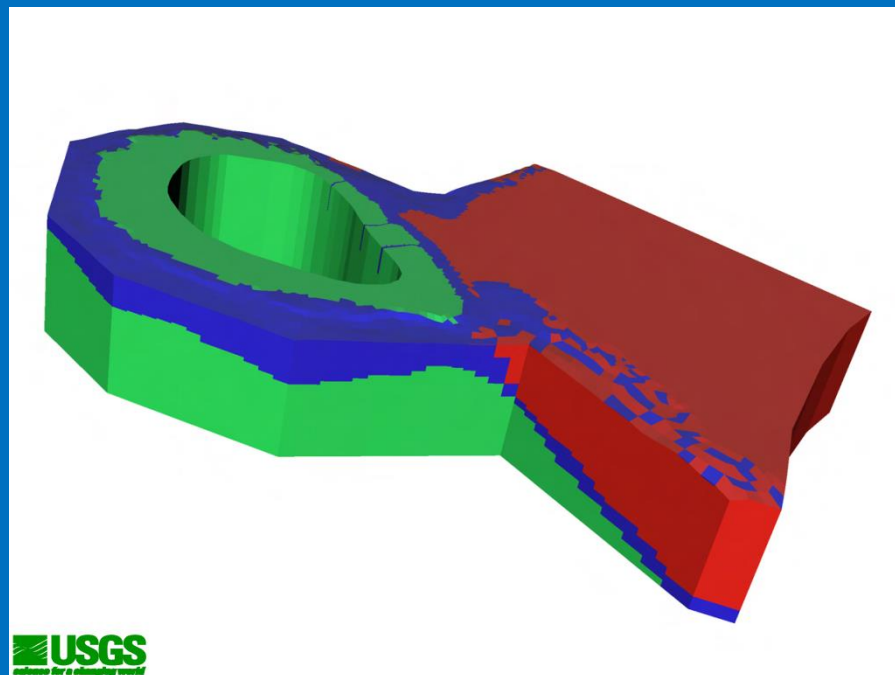
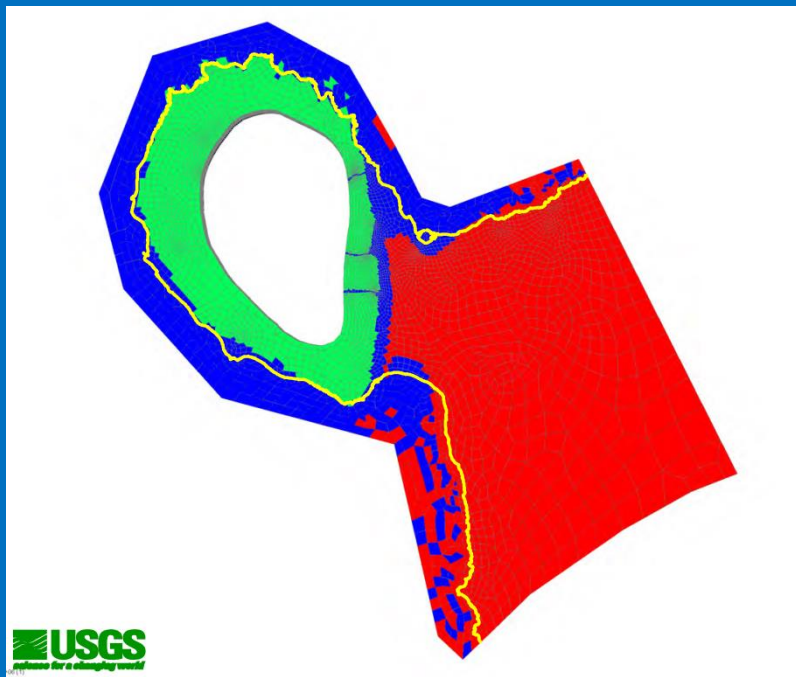




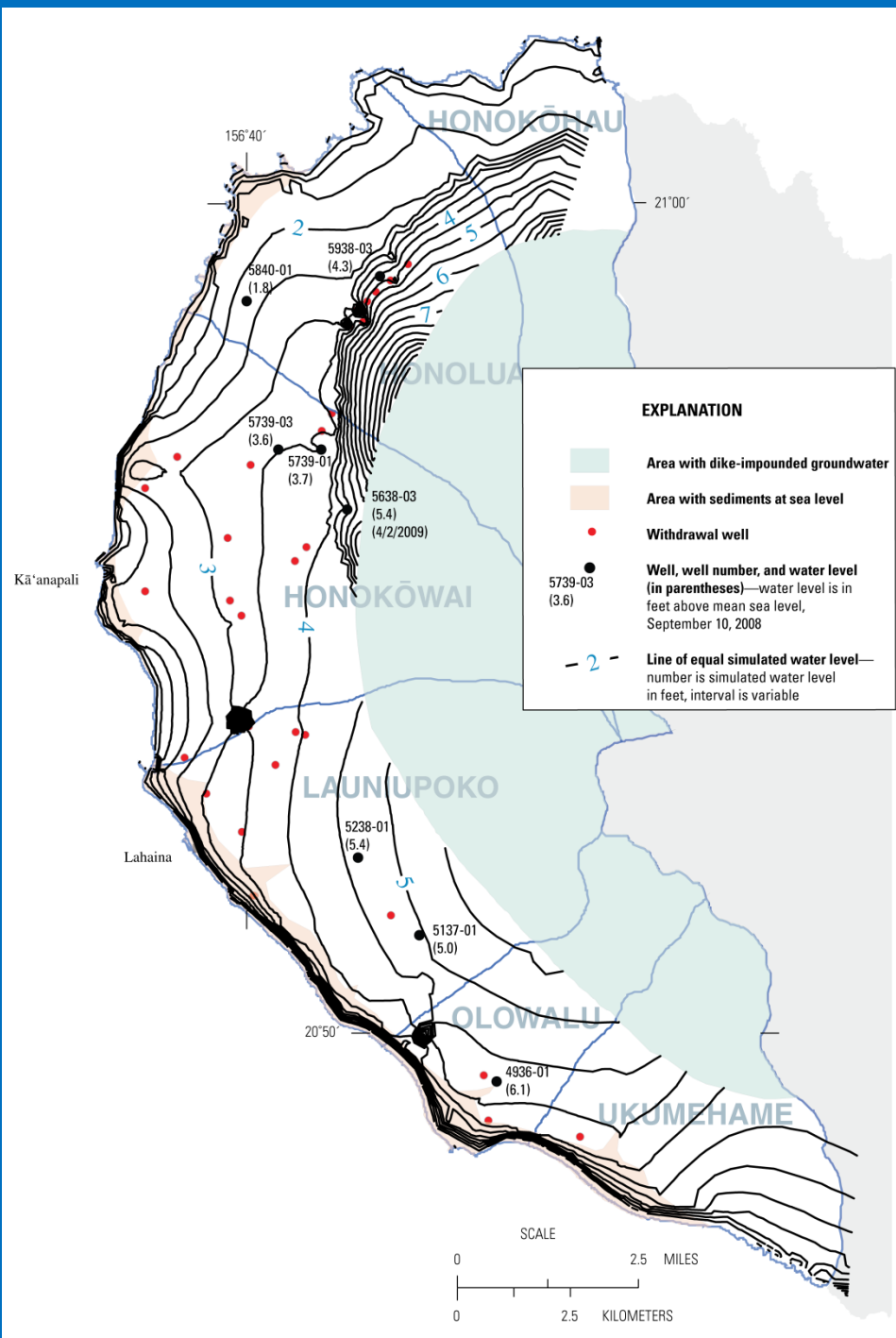
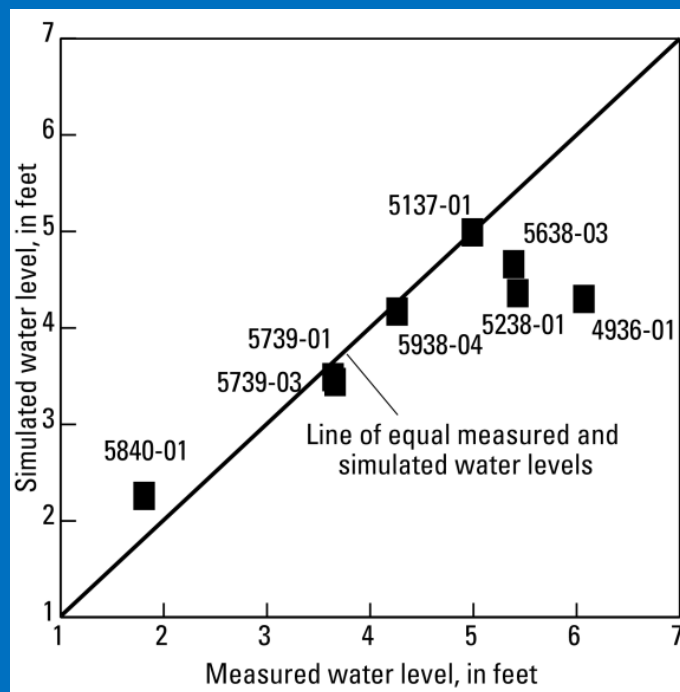
# Estimate Recharge



# Create Numerical Model

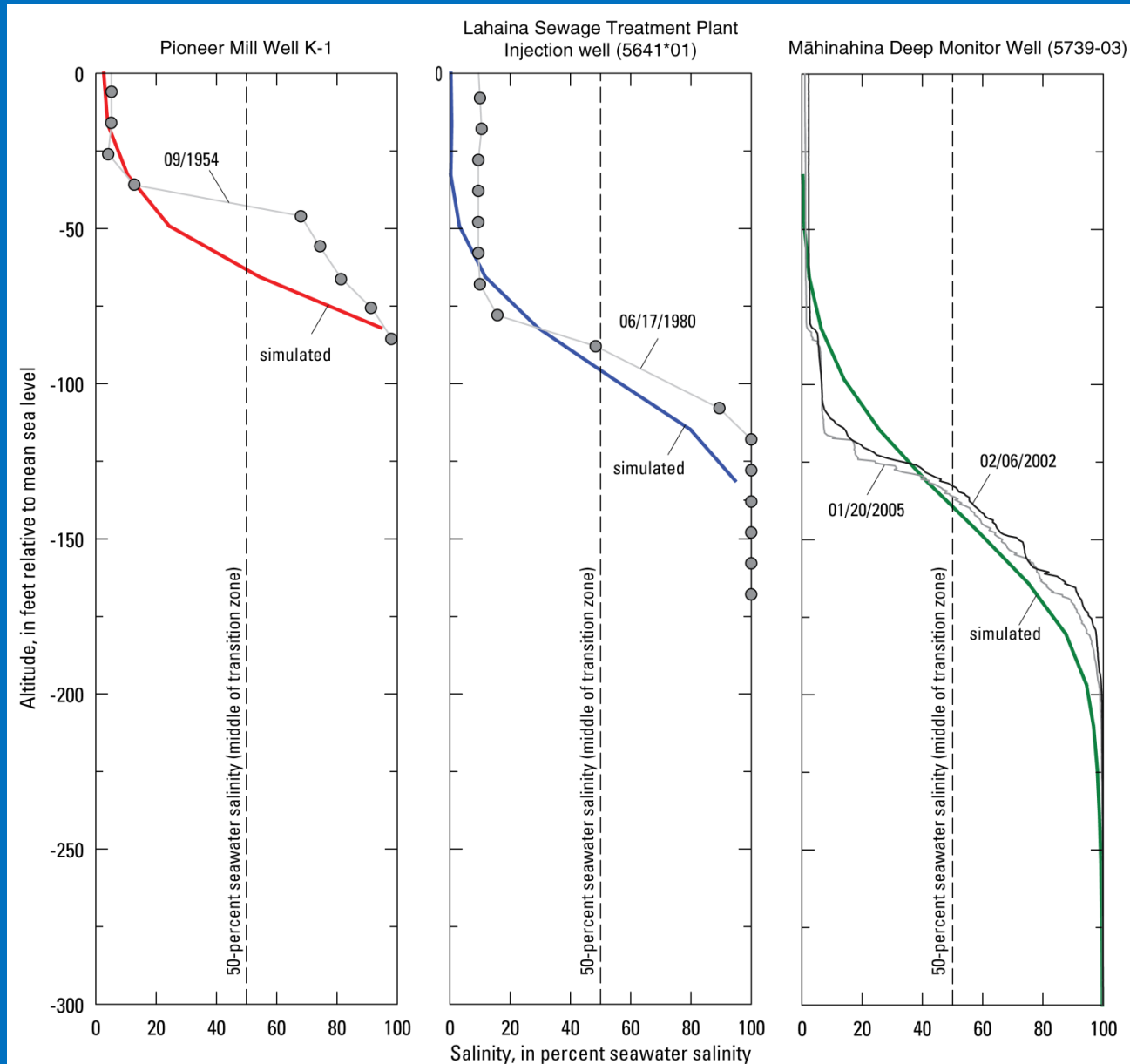
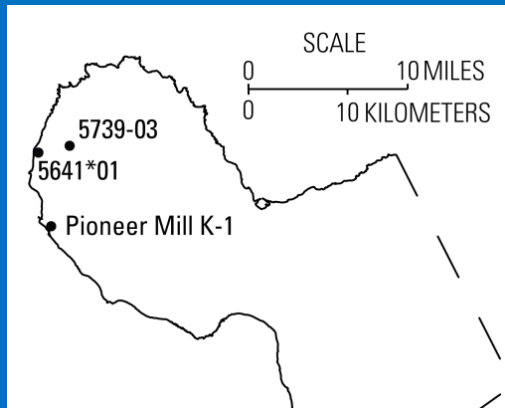


# Match Observed Water Levels





# Match Observed Salinity Profiles



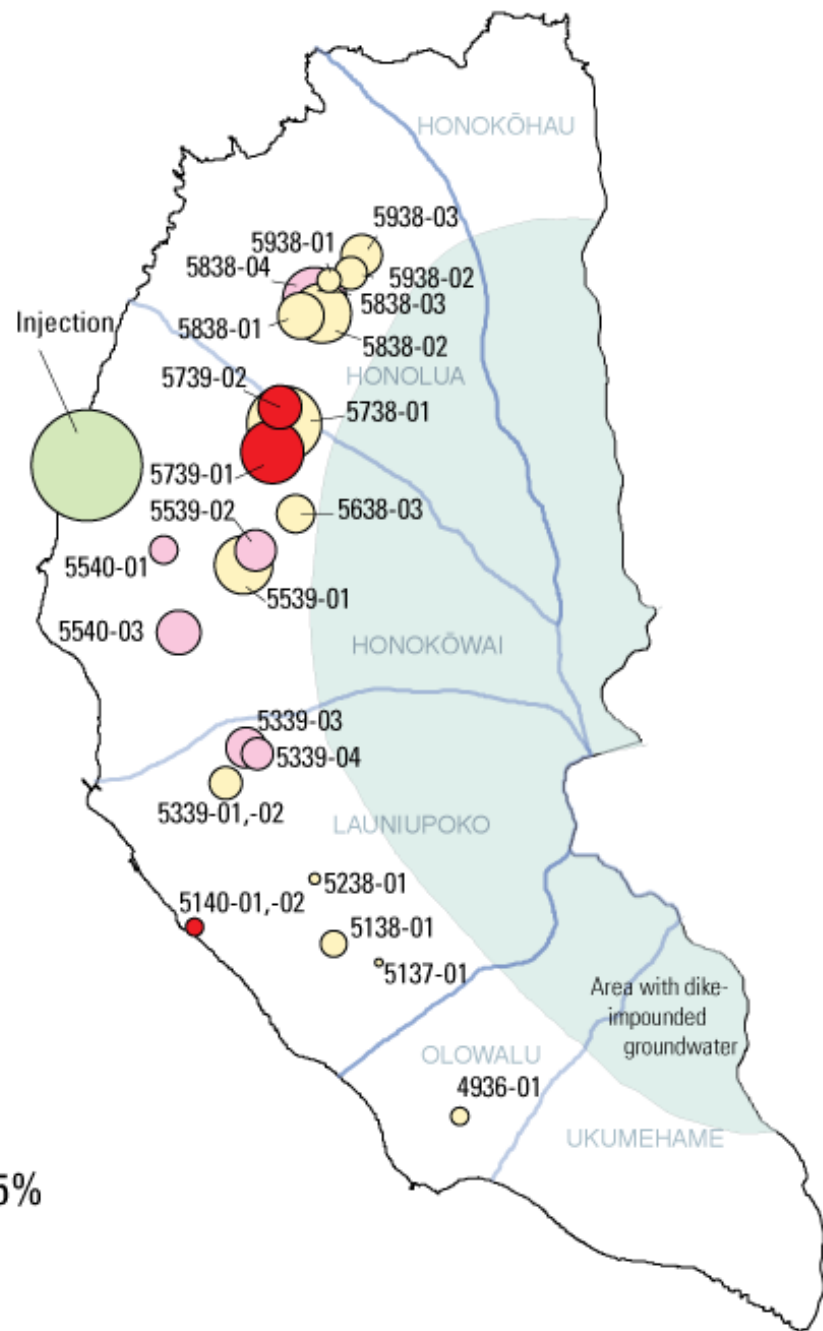
# Groundwater Management Questions

➔ Are current pumping rates sustainable?

- Where should we drill to get more water?
- How should we redistribute pumpage to maximize yield?
- How does wastewater injection affect groundwater system
- How will stream restoration affect groundwater system?



# Future results at current rates



0.25



less than 1%

0.5



from 1 to 2.5%

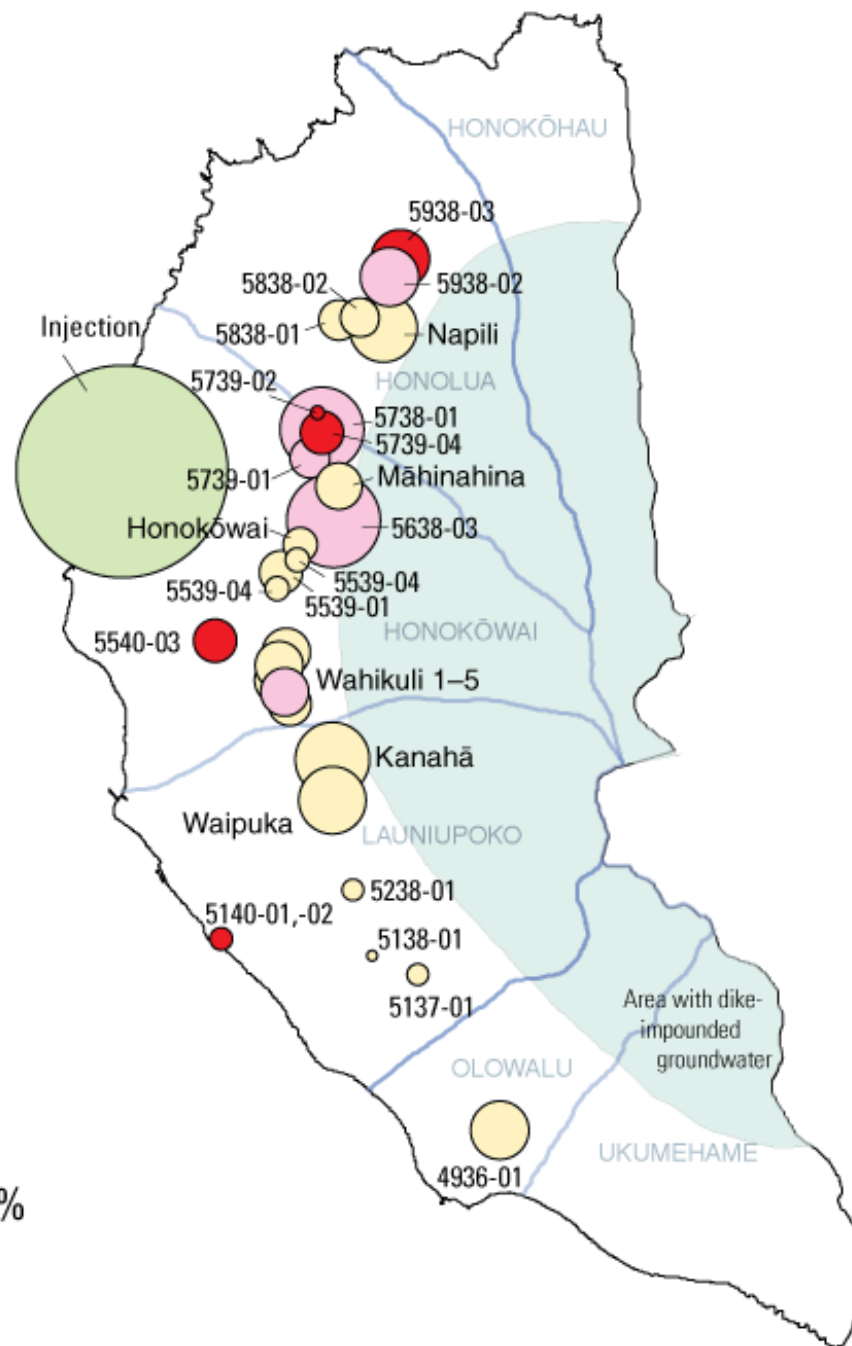
1.0 Mgal/d



more than 2.5%



# Future results at projected rates



0.25

0.5

1.0 Mgal/d



less than 1%

from 1 to 2.5%

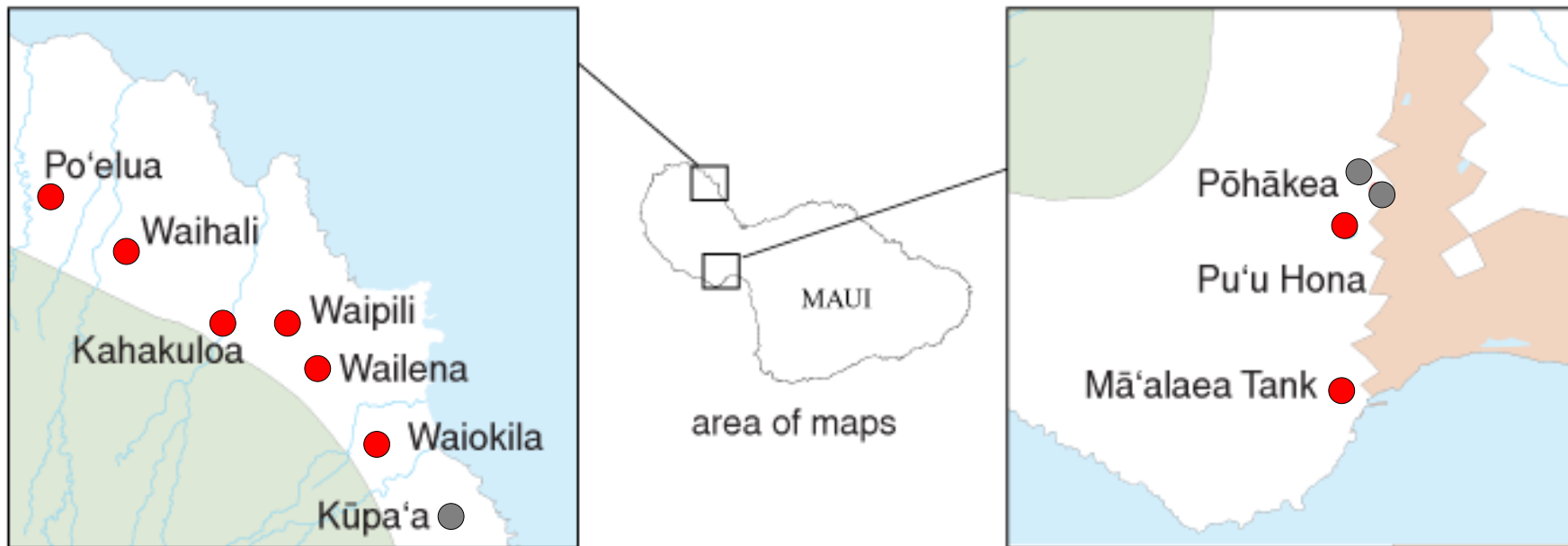
more than 2.5%

# Groundwater Management Questions

- Are current pumping rates sustainable?
- ➔ Where should we drill to get more water?
- How should we redistribute pumpage to maximize yield?
- How does wastewater injection affect groundwater system
- How will stream restoration affect groundwater system?



# Sites where withdrawal was tested



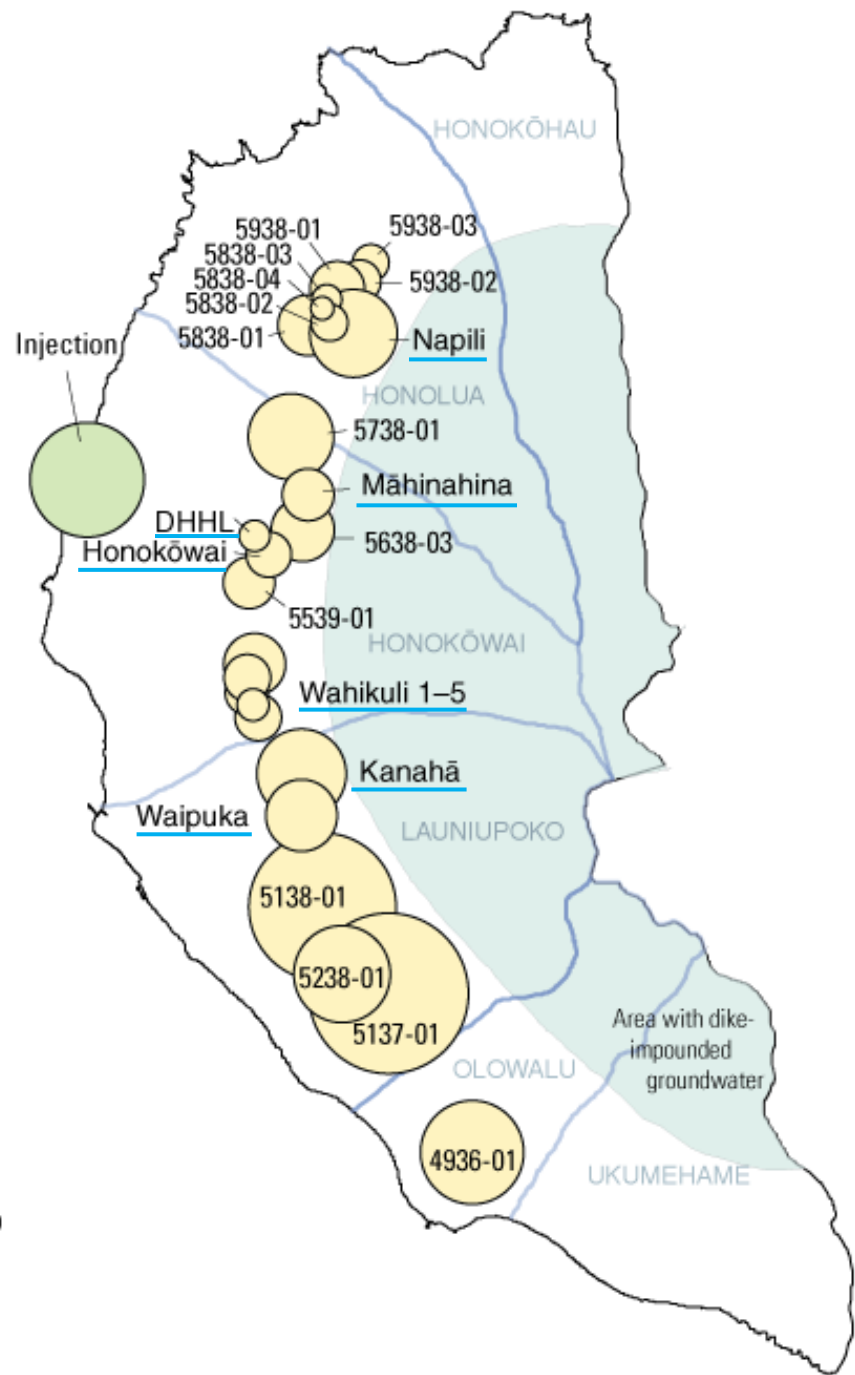


# Groundwater Management Questions

- Are current pumping rates sustainable?
- Where should we drill to get more water?
- ➔ How should we redistribute pumpage to maximize yield?
- How does wastewater injection affect groundwater system
- How will stream restoration affect groundwater system?



# Future results including new well locations and rates



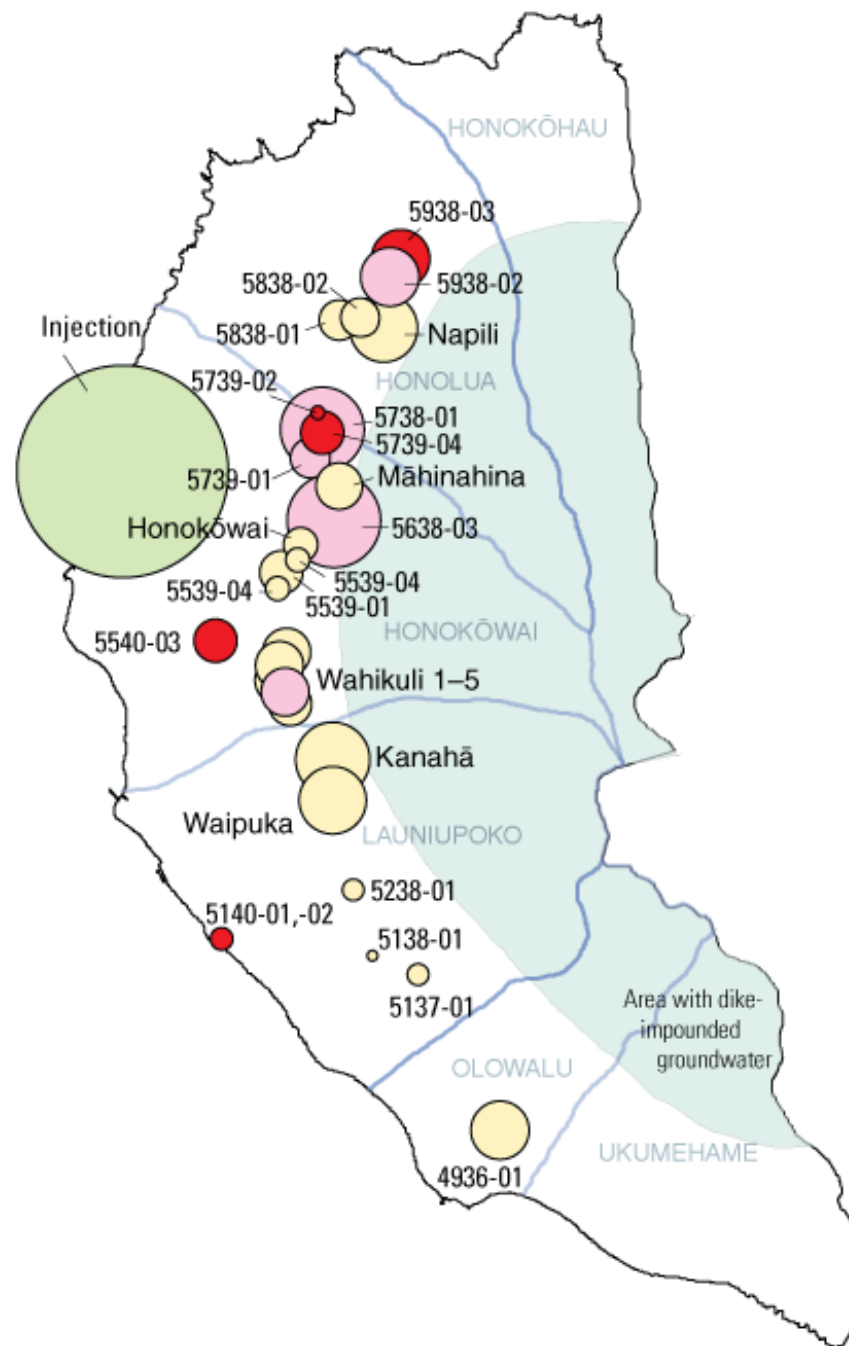
# Groundwater Management Questions

- Are current pumping rates sustainable?
- Where should we drill to get more water?
- How should we redistribute pumpage to maximize yield?
- ➔ How does wastewater injection affect groundwater system
- How will stream restoration affect groundwater system?

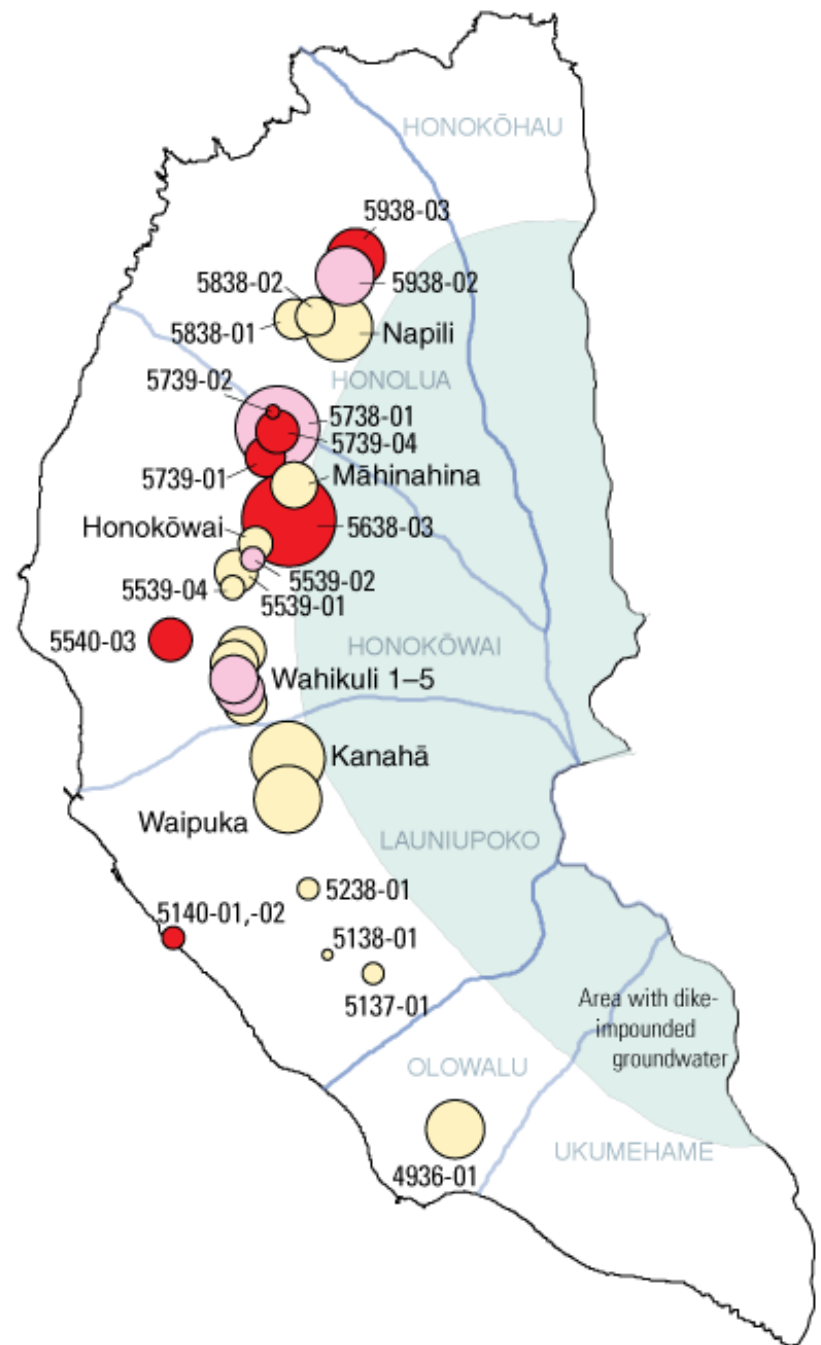




# Future results at projected rates



# Future results without injection well

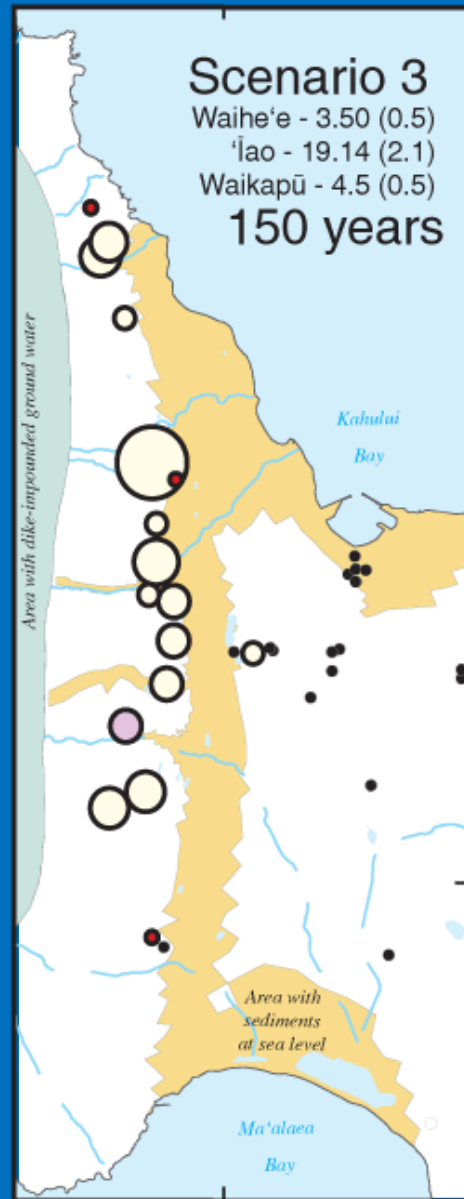


# Groundwater Management Questions

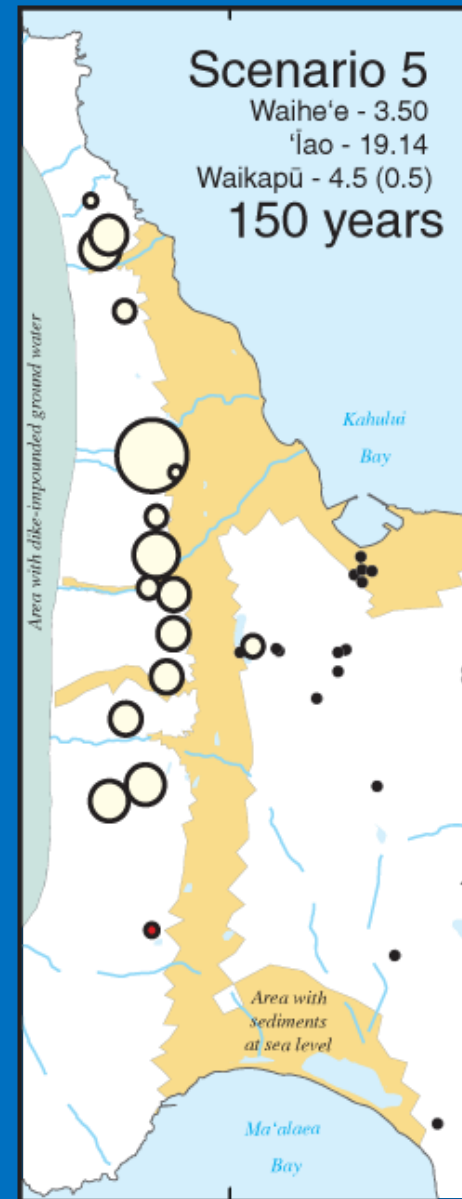
- Are current pumping rates sustainable?
  - Where should we drill to get more water?
  - How should we redistribute pumpage to maximize yield?
  - How does wastewater injection affect groundwater system
- ➔ How will stream restoration affect groundwater system?



# Future results with stream restoration



2006 conditions



12.3 Mgal/d recharge



# Value of Stakeholder Process

- Model helps stakeholders understand how their actions will impact each other
- Stakeholders shared future development plans to better understand cumulative impacts on the water resource
- Eases access and data sharing concerns when all stakeholders are engaged
- No surprises at the end of the study

# Summary

- Groundwater models help to answer management questions developed with stakeholder input
- Current pumpage distribution not sustainable for selected wells
- Redistributed pumpage can be sustainable
- Injection locally reduces saltwater intrusion
- Stream restoration could improve salinity in some wells

# Thank you

